TITLE OF THE INVENTION

METHOD OF ARRANGING DIVIDED RECORDING AREA SEGMENTS OF RECORDING MEDIUM IN BROADCAST RECEIVING SYSTEM

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of Korean Application No. 99-30938, filed July 28, 1999, in the Korean Patent Office, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to a broadcast receiving system which can simultaneously support time-delayed watching of a broadcast program and recording/reproduction of ~~the~~ another program, and in particular, to a method of arranging divided recording area segments in a recording medium to allow time-delayed watching of a broadcast program, while ~~the~~ another program is being recorded/reproduced.

2. Description of the Related Art

A hard disk drive (HDD) in a computer system is randomly accessible. Due to its advantages of low cost and large capacity relative to other auxiliary memories and a high data transmission rate, the HDD is used as a random access storage device for a broadcast receiving system.

A broadcast receiving system with a random access storage device enables simultaneous recording/reproduction and time-delayed broadcasting of video streams.

This can be achieved by controlling buffering of video streams input/output to/from an HDD.

There will be given a description of a method of arranging video streams on a hard disk surface as a recording medium in a broadcast receiving system which supports simultaneous time-delayed watching and recording/reproduction of the video streams.

FIG. 1 illustrates a hard disk managed as a circular buffer in a broadcast receiving system for time-delayed watching, and FIG. 2 illustrates a hard disk managed to record a plurality of video streams uncontinuously.

In the case of a hard disk managed as a circular buffer, video streams are recorded in blocks of a fixed size as shown in FIG. 1. A write point W and a read point R are set on a surface of the hard disk. New video streams are recorded, moving a head clockwise from the write point W, and predetermined video streams are played back by randomly accessing the circular buffer at a specific time.

On the other hand, to uncontinuously arrange video streams on a hard disk drive as shown in FIG. 2, a surface of the hard disk is divided into blocks of a fixed size and video streams are recorded in video files, each including a plurality of blocks. In this case, the blocks are not successively arranged because deletion of video files of different sizes result in uncontinuous free blocks. Information about each video file (title, time information, and so on) and information about the positions of blocks in each video file are recorded in a control information area.

FIGS. 3A through 3D are exemplary I/O (Input/Output) transaction scheduling diagrams for an HDD on/from which video streams are recorded/reproduced in real time. In FIGS. 3A through 3D, three video streams are processed using a C-LOOK algorithm by way of example. The C-LOOK algorithm is similar to a SCAN-Earliest-Deadline-First (SCAN-EDF) scheme disclosed in "I/O Issues in a Multimedia System," Reddy A.L.N. and Wyllie J.C., IEEE Computer Vol. 27. No. 3, March 1994, pp. 67-74, "Multimedia File Systems Survey: Approaches for Continuous Media Disk

Scheduling,"Ralf Steinmetz, Computer Communications, Vol. 18, No. 3, March 1995, pp. 133-144, and a gated operation disclosed in U.S. Patent No. 5,754,882. Hence, its description is omitted herein.

Referring to FIGS. 3B through 3D, video streams #1 and #2 are being played back and video stream #3 is being recorded. In most video stream processing methods, an HDD I/O control is implemented at every predetermined period T and video streams are processed in each period. For example, if video streams #1 and #2 are read from corresponding blocks on a hard disk surface in period T_{i-1}, they are played back in period T_i (this corresponds to consumption from a video processor's viewpoint). For continuous reproduction without interruption, blocks to be played back in the next period should be read from the HDD in the current period. For recording, blocks should be generated in the current period and then transmitted to the HDD in the next period. The order of processing video streams in a period depends on an I/O transaction scheduling scheme. In the C-LOOK algorithm, the order of processing video streams corresponds to a head moving direction. Assuming that a head of the HDD is moving from an outermost circumferential track to an innermost circumferential track and video stream blocks #1, 2, and 3 are located in tracks #10, 100, and 60, respectively, the video streams #1, 3, and 2 are ~~read~~ accessed to read or write in this order in T_i as shown in FIGS. 3A through 3D.

A broadcast receiving system which manages a hard disk area as a circular buffer as shown in FIG. 1 can reproduce a previously recorded video stream with a time delay while recording a ~~video stream~~. However, it cannot record and reproduce a plurality of video streams at the same time. In addition, video streams cannot be formed in video file units and an arbitrary video file cannot be deleted.

On the other hand, a broadcast receiving system which arranges video streams uncontinuously as shown in FIG. 2 can store recorded video streams in video files since it can utilize hard disk space freely. But buffer management for time-delayed watching is

not easy because blocks are not automatically reused in a limited area as compared to a circular buffer. This is because free blocks are scattered.

SUMMARY OF THE INVENTION

It is, therefore, an object of the present invention to provide a method of overcoming conventional problems encountered in using a recording area of a recording medium in a broadcast receiving system which can support time-delayed watching and recording/reproduction of a broadcast programs at the same time.

It is another object of the present invention to provide a method of efficiently managing divided recording area segments of a recording medium to simultaneously provide time-delayed watching and recording/reproduction of a plurality of video streams in a broadcast receiving system.

It is a further object of the present invention to provide a method of managing divided recording area segments of a recording medium to simultaneously provide time-delayed watching and high speed recording/reproduction of a plurality of video streams in a broadcast receiving system.

Additional objects and advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

These and other objects of the present invention can be achieved by providing a method of arranging divided recording area segments of a recording medium in a broadcast receiving system having a random access storage device. In the method, a circular buffer area is disposed in a first predetermined position of the recording medium, for recording a first broadcast signal in real time while reproducing a previously recorded second broadcast signal, a video file area is disposed in a second predetermined position of the recording medium, for recording a third broadcast signal in a logical file at a

predetermined time, and a control information area is disposed in a third predetermined position of the recording medium, for recording information about recorded files.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and advantages of the invention will become apparent and more readily appreciated from the following description of the preferred embodiments, taken in conjunction with the accompanying drawings of which:

The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings in which:

FIG. 1 illustrates a conventional hard disk managed as a circular buffer in a broadcast receiving system for time-delayed watching;

FIG. 2 illustrates a conventional hard disk managed to arrange a plurality of video streams uncontinuously;

FIGS. 3A through 3D are exemplary I/O transaction scheduling diagrams of a conventional HDD for recording and reproducing a plurality of video streams in real time;

FIG. 4 is a block diagram of a broadcast receiving system which can support time-delayed watching and recording/reproduction of a broadcast program according to an embodiment of the present invention;

FIG. 5 illustrates arrangement of hard disk recording area segments according to the embodiment of the present invention;

FIG. 6 illustrates video streams recorded in the hard disk recording area segments according to the embodiment of the present invention;

FIG. 7 illustrates a procedure of processing streams assigned as shown in FIG. 6 in a C-LOOK algorithm; and

FIG. 8 is a simplified view of a hard disk recording area according to the embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the present invention will be described hereinbelow with reference to the accompanying drawings. In the following description, well-known functions or constructions are not described in detail since they would obscure the invention in unnecessary detail.

FIG. 4 is a block diagram of a broadcast receiving system capable of broadcasting a program with a time delay and recording/reproducing another program simultaneously.

Referring to FIG. 4, a broadcast signal receiver 10 includes an RF (Radio Frequency) tuner 12 for receiving an external digital broadcast signal, RF tuners 14 and 16 for receiving external analog broadcast signals, and video compressors 18 and 20 for converting analog signals received from the RF tuners 14 and 16 to digital signals and compressing the converted digital signals, respectively.

A random access storage device 30 records digital video streams received from the broadcast signal receiver 10 on a hard disk surface (not shown), reads the stored video streams, and outputs the read video streams to a video recovery unit 50 under the control of a controller 40. As is well known, the random access storage device 30 comprises the dual port RAM 32 for temporarily storing the digital video streams, a hard disk (hard disks) for permanently storing the digital video streams, an HDD controller for controlling the HDD to be driven, and a expander for expanding the HDD. The expander is an IEEE 1394 interface.

The video recovery unit 50 recovers a video stream received from the random access storage device 30 through a system bus to an original signal and outputs the recovered original signal to a TV receiver 90.

The controller 40 includes a ROM for storing control program data to control the random access storage device 30 and the broadcast signal receiver 10 and a RAM for temporarily storing data generated during a control operation.

A remote controller 60 has a plurality of adjustment keys for system control, generates data corresponding to a key input, and feeds the data to the controller 40. The adjustment keys are "pause", "rewind", "rapid search", and so on.

A computer interface 70 interfaces a transmitted/received signal between the broadcast receiving system of the embodiment of the present invention and a computer. A timer 80 generates time information so that the broadcast receiving system can record a program automatically.

FIG. 5 illustrates a hard disk recording area according to the embodiment of the present invention. Here, the recording area is divided into four segments. The hard disk recording area covers the area from an outermost circumferential track (track #0) to an innermost circumferential track (track #n). The hard disk recording area is divided into video file areas #1 and #2 110A and 110B, a control information area 120, a circular buffer area 130 for time-delayed watching, and a general file area 140, to thereby enable simultaneous time-delayed watching and recording/reproducing of ~~a~~ broadcast programs with efficiency.

The circular buffer area 130 is used to record a broadcast signal which is currently being broadcast and reproduce a previously recorded broadcast signal in real time. The circular buffer area 130 can be positioned anywhere in the hard disk recording area, preferably includes tracks at both sides of a center track (2/n) to minimize a search time of a head for time-delayed watching and recording/reproducing a specific channel broadcast signal at the same time.

The video file areas #1 and #2 110a and 110B, arranged respectively in outer circumferential tracks and inner circumferential tracks, are used to record a broadcast program at a reserved time. In the video file areas 110a and 110b, recorded video

streams are arranged uncontinuously in logical files according to a recorded time as shown in FIG. 2.

The general file area 140 is also managed in the non-continuous arranging method to store information other than continuous information like video streams.

The control information area 120 stores information related with each video file, such as title and time information and positions of blocks in each file.

FIG. 6 illustrates video streams recorded and stored in the hard disk recording area divided according to the embodiment of the present invention. Here, four video stream blocks are arranged in their corresponding areas. FIG. 7 illustrates a procedure of processing each stream assigned as shown in FIG. 6 in a C-LOOK algorithm.

In FIG. 6, video stream #1 220 is being recorded in the circular buffer area 130 for time-delayed watching. Video stream #2 210 is already recorded for time-delayed watching. Video stream #3 230 is being recorded in video file area #2 110B and has nothing to do with a program currently ~~being broadcast~~. Video stream #4 is already recorded in video file area #1 110A.

If time-delayed watching and reproduction are selected simultaneously, video streams are read or recorded in an ascending track number order in the C-LOOK algorithm. In this case, a video stream I/O processing order of the HDD 34 is 4, 2, 1, and 3. Thus, video streams #1 and #3 220 and 230 are input to the dual port RAM 32 in T_{i-1} and recorded in assigned recording areas of the HDD 34. Meanwhile, video streams #2 and #4 210 and 200 are read from the hard disk recording area in T_i and output to the video recovery unit 50 in T_{i+1}. On the assumption that video streams are continuously reproduced without delay, a video stream should be read from the recording area in each period so that it can be reproduced in the next period. For recording, a video stream should be generated in the period previous to a recording period.

As described above, arrangement of the circular buffer area 130 in the center of the hard disk recording area can minimize an average head moving time, that is, an average search time, as compared to an otherwise case.

FIG. 8 is a simplified view of the hard disk area according to the embodiment of the present invention. In FIG. 8, tracks where two video stream blocks are recorded are spaced from n by i and j, respectively. If a circular buffer area is positioned at n, i tracks should be searched to process a video stream in the circular buffer area and other two video stream blocks in the C-LOOK algorithm. On the other hand, if the circular buffer area is positioned at track #0, (i+n) tracks, an n-increased distance should be searched. In this context, the present invention can reduce a head moving time since time-delayed watching can be implemented simultaneously with recording/reproduction.

In accordance with the present invention as described above, a recording area of a recording medium is divided into a circular buffer area and a non-continuous file area in a broadcast receiving system capable of simultaneous time-delayed watching and recording/reproduction of a broadcast program. Hence, the recording area in a limited space is automatically reused and video streams are formed in logical video files. In addition, recorded video files can be selectively deleted, a head search time is reduced, and a data access rate is increased.

While the invention has been shown and described with reference to a certain preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.